Interplanar Spacing

The distance between two adjacent parallel planes of atoms with the same Miller indices is called the **interplanar spacing** (d_{hkl}). The interplanar spacing in *cubic* materials is given by the general equation

$$d_{hkl} = \frac{a_0}{\sqrt{h^2 + k^2 + l^2}},$$

Where *a*0 is the lattice parameter and *h*, *k*, and *l* represent the Miller indices of the adjacent planes being considered. The interplanar spacings for non-cubic materials are given by more complex expressions.

Diffraction Techniques for Crystal Structure Analysis

A crystal structure of a crystalline material can be analyzed using **x-ray diffraction (XRD)**or electron diffraction. When a beam of x-rays having a single wavelength on the same order of magnitude as the atomic spacing in the material strikes that material, x-rays are scattered in all directions. Most of the radiation scattered from one atom cancels out radiation scattered from other atoms; however, x-rays that strike certain crystallographic planes at specific angles are reinforced rather than annihilated. This phenomenon is called **diffraction**. The X-rays are diffracted, or the beam is reinforced, when conditions satisfy **Bragg's law**,

$$\sin\theta = \frac{\lambda}{2d_{hkl}}$$

where the angle θ is half the angle between the diffracted beam and the original beam direction, λ is the wavelength of the x-rays, and d_{hkl} is the interplanar spacing between the planes that cause constructive reinforcement of the beam.

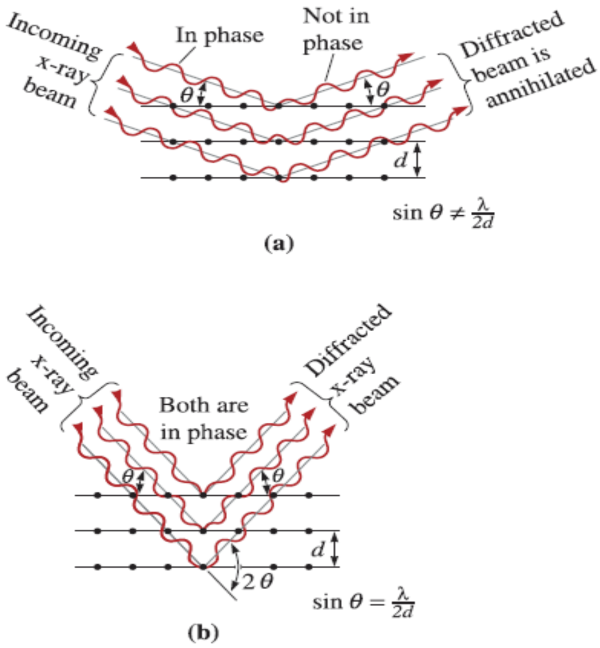

Figure 3-36
(a) Destructive and (b) reinforcing interactions between x-rays and the crystalline material. Reinforcement occurs at angles that satisfy Bragg's law.

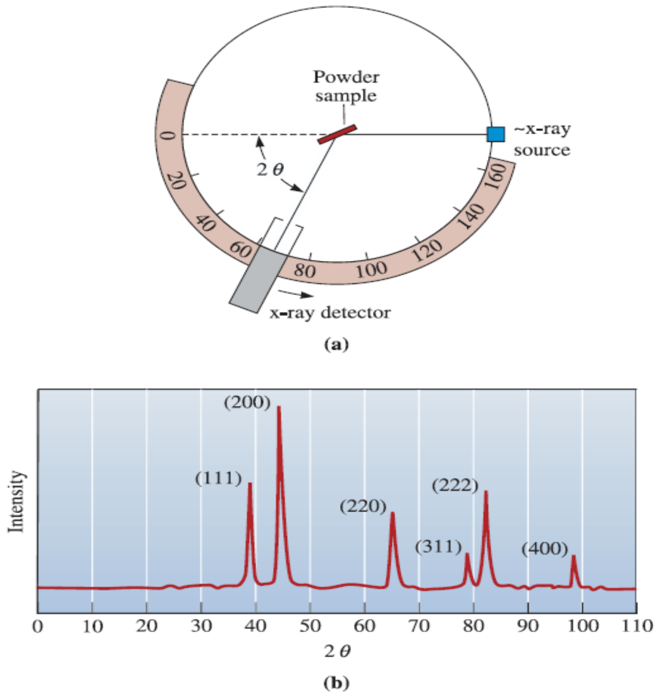

Figure 3-37 (a) Diagram of a diffractometer, showing powder sample, incident and diffracted beams. (b) The diffraction pattern obtained from a sample of gold powder.

H.W

1)Determine the indices for the directions in the cubic unit cell shown in Figure 3-40.

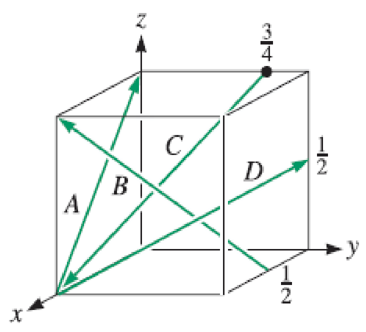

Figure 3-40 Directions in a cubic unit cell for Problem 3-42.

2) Determine the indices for the planes in the cubic unit cell shown in Figure 3-41.

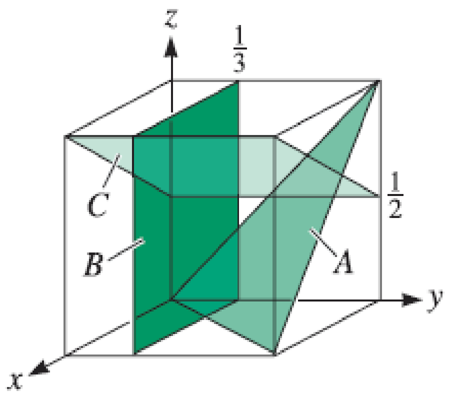

Figure 3-41 Planes in a cubic unit cell for Problem 3-43.

3) A diffracted x-ray beam is observed from the (220) planes of iron at a 2θ angle of 99.1° when x-rays wavelength 0.15418 nm are used. Calculate the lattice parameter of the iron?

Classification of the metal alloys:

All metal alloys may be classified as ferrous or nonferrous alloys. A ferrous alloys has iron as its main element. A alloy is still considered ferrous even if it contains less than 50 percent iron, as long as it contains more iron than any other one metal. A alloy is nonferrous if it contains less iron than any other metal.

1 -Ferrous alloys are that contain iron as the base metal. The properties of ferrous alloys may be changed by adding various alloying elements. Ferrous alloys include steel, cast iron and the various steel alloys.

2 -Nonferrous alloys

Classification of ferrous alloys:

Ferrous alloys include steel, cast iron and the various steel alloys, The only difference between iron and steel is the carbon content. **Cast iron** contains more than 2-percent carbon, while **steel** contains less than 2percent. An alloy is a substance composed of two or more elements.Therefore, all steels are an alloy of iron and carbon, but the term “alloy steel” normally refers to a steel that also contains one or more other elements. For example, if the main alloying element is tungsten, the steel is a “tungsten steel” or “tungsten alloy.” If there is no alloying material, it is a “carbon steel.” Classification of ferrous alloys is shown in figure(1)

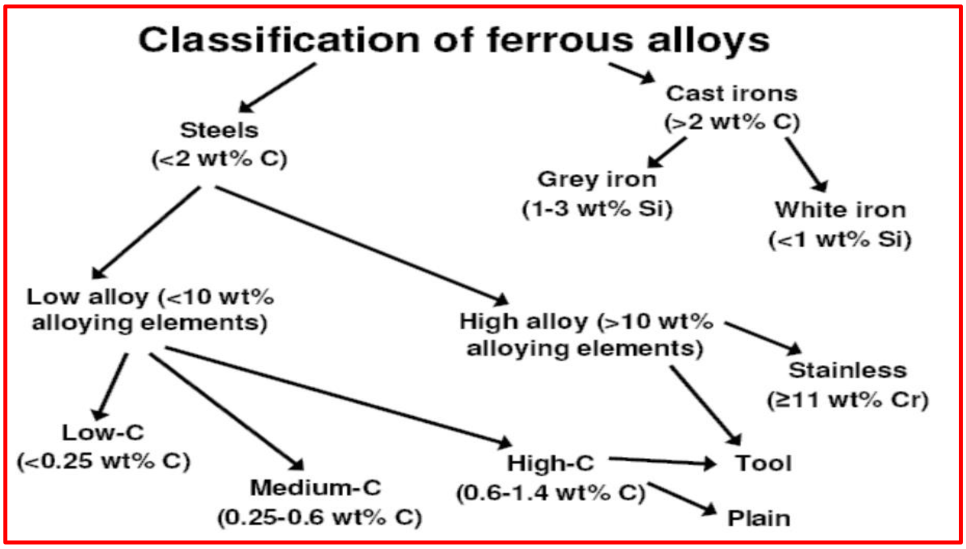

Figure (1) classification of ferrous alloys.

Characteristics of Ferrous Metals

- Durable.
- Great tensile strength.
- Usually magnetic.
- Low resistance to corrosion.
- A silver-like color.
- Recyclable.
- Good conductors of electricity.

Nonferrous alloys

Nonferrous alloys (i.e., alloys of elements other than iron) include, but are not limited to, alloys based on aluminum, copper, nickel, cobalt, zinc, precious metals (such as Pt, Au, Ag, Pd), and other metals (e.g., Nb, Ta, W).

In many applications, weight is a critical factor. To relate the strength of the material to its weight, a **specific strength**, or strength-to-weight ratio, is defined:

Specific strength= strength/density

Super alloys

Super alloys are nickel, iron-nickel, and cobalt alloys that contain large amounts of alloying elements intended to produce a combination of high strength at elevated temperatures, resistance to creep at temperatures up to 1000°C, and resistance to corrosion. Typical applications include vanes and blades for turbine and jet engines, heat exchangers, chemical reaction vessel components, and heat-treating equipment.